AD-A148 885 AN ALIGNMENT FIXTURE FOR A TWO-DEGREE-OF-FREEDOM (TDF) GYROSCOPE(U) DEFENCE RESEARCH ESTABLISHMENT OTTAWA (ONTARIO) R G APPS JUN 84 DREO-TN-84-5 1/1

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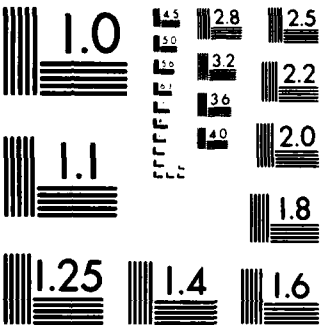


AD-A148 885

AN ALIGNMENT FIXTURE FOR A TWO-DEGREE-OF-FREEDOM TOE STRUCTURE

by

R.G. Apps

DEFENCE RESEARCH ESTABLISHMENT OTTAWA
TECHNICAL NOTE 84-8

National Defence / Défense nationale

AN ALIGNMENT FIXTURE FOR A TWO-DEGREE-OF-FREEDOM (TDF) GYROSCOPE

by

R.G. Apps
Electromagnetics Section
Electronics Division

DEFENCE RESEARCH ESTABLISHMENT OTTAWA
TECHNICAL NOTE 84-5

PCN
32G00

June 1984
Ottawa

ABSTRACT

A description of the Honeywell GG1111 Single-Degree-Of Freedom (SDF) strapdown gyroscope alignment fixture and it's shortcomings are presented. The requirements for a new all aluminum alignment fixture for the Litton CSG-2 Two-Degree-Of-Freedom (TDF) strapdown gyroscope are discussed. A description of the new alignment fixture package is presented.

RESUME

Le système d'alignement du gyroscope à composants liés à un degré de liberté Honeywell GG1111 et ses inconvénients sont décrits. On discute de la nécessité d'un nouveau système d'alignement tout aluminium pour le gyroscope à composants liés à deux degrés de liberté Litton CSG-2. On décrit le nouveau système d'alignement.

TABLE OF CONTENTS

1.0 HONEYWELL GG1111 SINGLE-DEGREE-OF-FREEDOM STRAPDOWN GYROSCOPE ALIGNMENT FIXTURE

1.0 For laboratory testing the Honeywell GG1111 strapdown gyroscope was mounted in a temperature controlled two element aluminum fixture which permitted alignment of the gyroscope with the test table. The upper element (gyroscope housing) allows rotation of the gyroscope, while the lower element provides the temperature control and tip and tilt adjustment (Fig. 1).

Three problems were encountered during alignment and testing of the gyroscope. First, too coarse a rotation adjustment in the upper element, second non-uniform temperature of gyroscope and poor temperature control and last, coarse tip and tilt adjustment in the lower element.

1.1 COARSE ROTATION ADJUSTMENT

Rotation of the gyroscope is achieved by loosening four Allen socket head screws on the front flange and manually rotating the gyroscope (Fig. 2). Because of various factors, an optimum accuracy of 0.005" of arc or 34 arc minutes is possible in a manual adjustment in rotation. An accuracy of 20 to 30 arc seconds is desirable.

1.2 NON UNIFORM TEMPERATURE OF GYROSCOPE AND POOR TEMPERATURE CONTROL

The operating temperature of the Honeywell GG1111 gyroscope is 185°F (85°C). This temperature is maintained by two heaters in the lower element of the fixture. (Fig. 1). Only one half of the gyroscope is encased in the upper element, leaving the other half exposed to the environment. A large temperature gradient was suspected between the encased and exposed ends of the gyroscope. Two thermistor sensors were strategically positioned, one was glued to the exposed body of the gyroscope near the leads, the other was glued to the fixture near the temperature control sensor. A temperature gradient test was performed with the fixture oriented in various positions. For each of the positions the temperature was allowed to stabilize for one hour before a reading was taken. An average 9 °C temperature gradient between the encased and exposed ends of the gyroscope was observed. Poor temperature control was achieved for two reasons; the control sensor was positioned too far from the heaters causing an overshoot. And second, one half of the gyroscope was exposed to the environment and should have been totally encased in a foam covered aluminum block.

1.3 COARSE TIP AND TILT ADJUSTMENT

The tip and tilt adjustment permits alignment of the gyroscope spin reference axis with the spin axis of the test table. This adjustment is provided by three spring loaded 1/4-20 Allen socket head bolts (Fig. 2). A 1/4-20 bolt has 20 threads per inch of length providing a displacement of 0.050" for each full revolution. This coarse adjustment makes the alignment of the gyroscope with the test table difficult.

2.0 LITTON CSG-2 TWO-DEGREE-OF-FREEDOM STRAPDOWN GYROSCOPE ALIGNMENT FIXTURE

For the laboratory testing of the Litton CSG-2 two-degree-of-freedom strapdown gyroscope a precise alignment fixture with good temperature control, stability and even heat distribution was required. A new three element mechanical fixture was designed. The package consists of an all aluminum temperature controlled gyroscope fixture, a rotation stage and a two axis tip and tilt positionner (Fig. 3).

3.0 ALUMINUM TEMPERATURE CONTROLLED GYROSCOPE FIXTURE

It was felt that the thermal gradients and temperature instability in the gyroscope could be dramatically reduced by encasing the gyroscope in a polyethylene foam covered aluminum block (DREO drawings no. 3530, 3531, 3532, 3533). In order to provide a uniform temperature distribution through the gyroscope, four evenly spaced 225 watt, 240 volt superwatt heaters were positioned around it's circumference (Fig. 4). The four heaters were wired in parallel and controlled with a 60 volt temperature controller providing 225 watts total heating power. Good temperature control and stability was achieved by positioning the temperature control sensor near a heater (Fig. 3), isolating the gyroscope fixture from the remainder of the package with quartz washers and 1/4" thick polyethylene foam padding, and covering the fixutre with a 1/2" of polyethylene foam.

3.1 ROTATION STAGE

For the rotation of the gyroscope (alignment of the Y input axis west) an Opticon type TR-80 rotation stage 75 MM. Dia. X 35 MM. high complete with locking fine adjustment with an accuracy of 1 arc second and a sensitivity of 3 arc seconds was purchased (Fig. 5).

3.2 TWO AXIS TIP AND TILT POSITIONER

For the levelling of the gyroscope (alignment with the test table) a PI model P-044 two axis tip and tilt positioner with a working surface of 100 MM. X 100 MM. and a tilt range of ± 10° was purchased (Fig. 6). The tip and tilt action of the gyroscope controlled by two micrometers each linked to the moveable tip and tilt positioning elements using spring coupling (Fig. 4). Because the combined weight of the rotation stage, the gyroscope and it's fixture compressed the original springs, a new more rigid set was installed.

4.0 ASSEMBLY OF THE GYROSCOPE ALIGNMENT FIXTURE PACKAGE

The PI two axis tip and tilt positioner was fastened to the three sided fixture with two 10-32 fillister socket head screws (Fig. 7). The rotation stage was positioned on the two axis tip and tilt positioner and held in place with four hold down clamps (Fig. 7). In order to mate the gyroscope fixture to the rotation stage, a stainlness steel spacer adapter plate was machined (Fig. 8). The plate was fastened to the rotation stage with four 10-32 stainless steel flat head screws. The gyroscope fixture was then fastened to the spacer adapter plate with three stainless steel binding head screws with quartz spacer washers and 1/4" thick polyethylene foam padding. The quartz washers and the 1/4" foam padding reduce the heat transfer from the gyroscope fixture to the remainder of the package. The gyroscope fixture was covered with 1/2" polyethylene foam. The assembled alignment fixture package on the test table is shown in (Fig. 9).

5.0 TEMPERATURE GRADIENT TEST

A temperature gradient test was performed, the temperature of the CSG-2 gyroscope was monitored at the top center, belly band and bottom center. The temperatures were monitored during warm-up and until an operating temperature of 70.3°C was obtained. Temperatures observed after stabilization were top center 70.6°C, belly band 70.3°C and bottom center 70.0°C. The temperature gradient from the bottom center to the top center of the gyroscope is 0.6°C. Temperature stability at the belly band 70.3± 0.05°C.

6.0 CONCLUSIONS

The requirements of a precise alignment fixture with good temperature control, stability and even heat distribution were met with the new fixture design. The temperature gradient through the gyroscope was reduced to 0.6°C from 9°C with the old fixture design. A temperature stability of ± 0.05°C of set temperature was achieved.

REFERENCE

A) R. Apps and M. Vinnins. Procedures For Static And Constant-Rate Tests On A Single-Degree-of-Freedom (SDF) Strapdown Gyroscope.

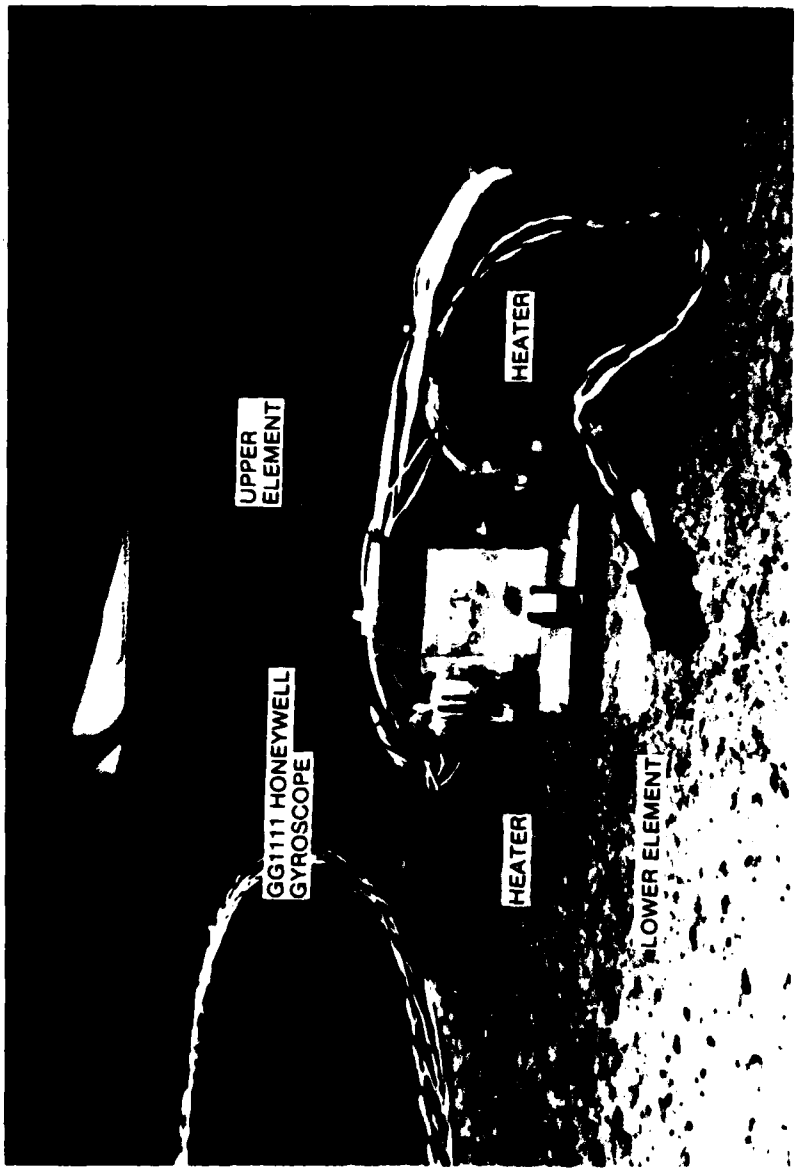


Fig. No. 1. GG1111 Mounted In Alignment Fixture

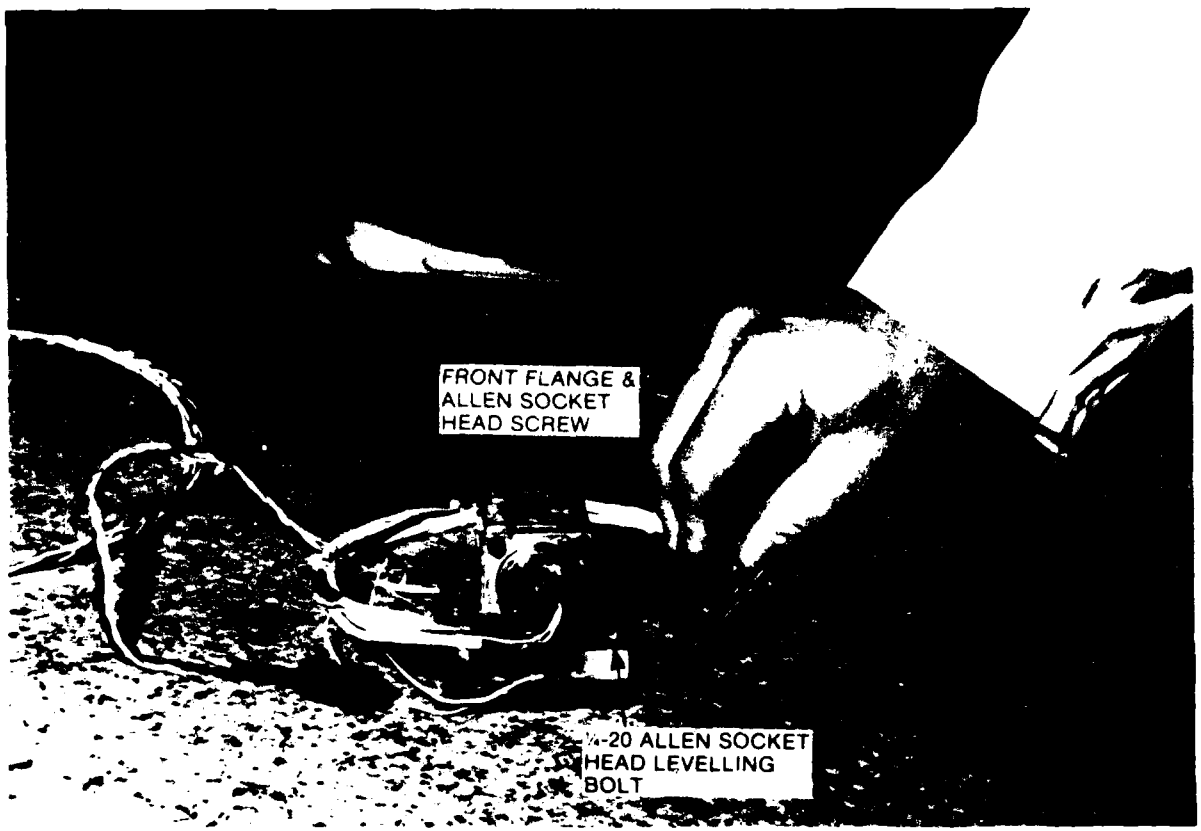


Fig. No. 2. GG1111 Gyro And Alignment Fixture

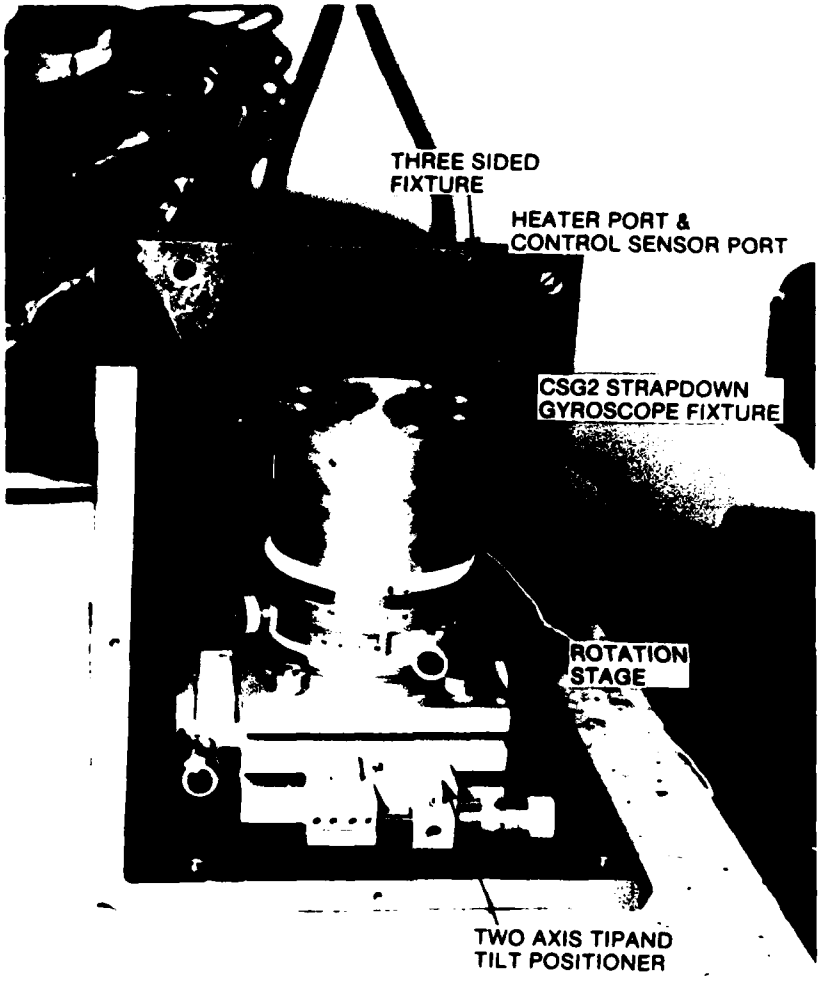


Fig. No. 3. Two-Degree-Of-Freedom Strapdown Gyroscope Alignment Fixture Package Mounted On A Three Side Fixture

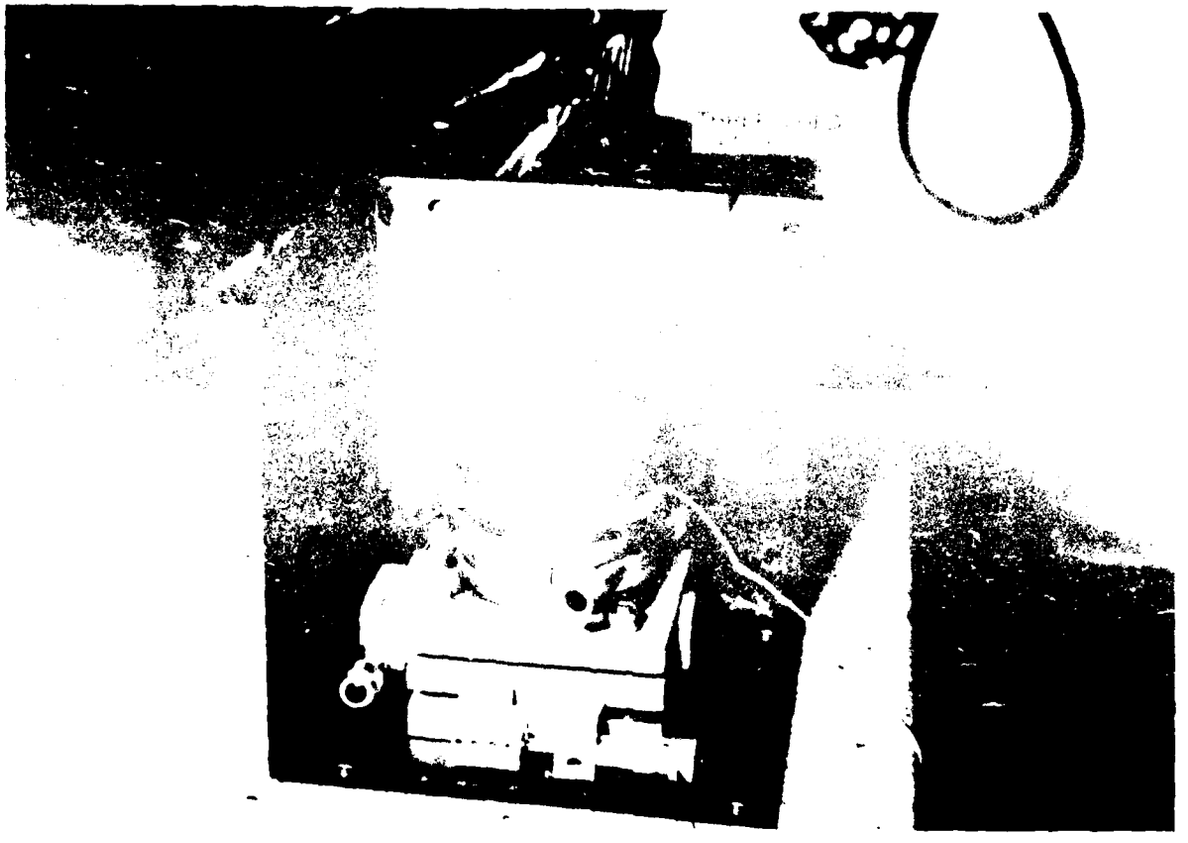
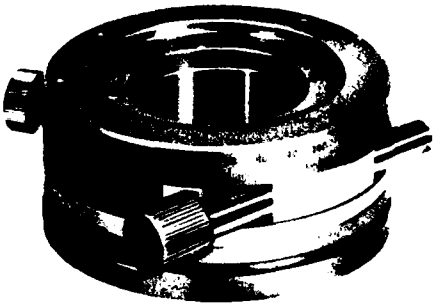
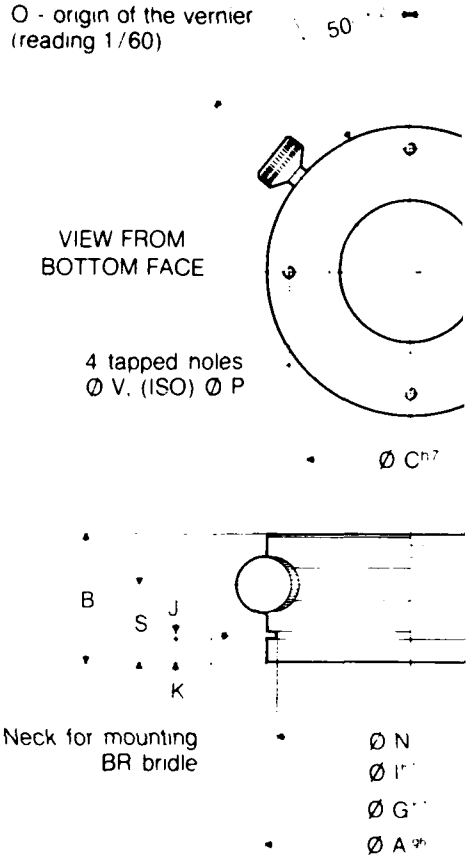


Fig. No. 4 Opened Gyroscope Fixture Showing Heater Ports

rotation stages type TR





	A	B	C	D	E	G	I	J	K	N	P	Q	S	T
TR 46	46	28	30	2	21.3	21	18	2	5	43	38	4	17.5	30
TR 80	80	35	58	3	26.2	45	40	2	6	75	68	4.5	21.5	50
TR 80S	80	18	58	2	13.5	55	50	2.5	3	75	68	—	16.8	38
TR 120	120	42	84	3	32.5	70	64	3	8	114	105	5	26.5	62
TR 160	160	60	120	4	46.3	100	90	3	10	150	140	6.7	40.5	84

Fig. No. 5. Rotation Stages Type TR

Tip and tilt positioners

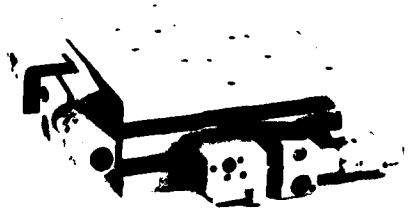
These positioners allow the mounted components to be inclined by an adjusted amount within the range ± 10°. **PI** tip and tilt positioners are available in the standard sizes 60 × 60 mm and 100 × 100 mm and any other sizes and allow tip/tilt. The tip and tilt motions are adjusted, the amount of angles measured by micrometers. The micrometers are each linked to the moveable tip and tilt positioning elements by using spring coupling. The axes of the tip and tilt positioners rest on ball bearings.

P-041 (Fig. 84 B) – **Tilt positioner** on one axis, base area and working surface 60 × 60 mm, tilt range ± 10°

P-042 (Fig. 84 C) – **Tip and tilt positioner** on two axes, size and tip and tilt range as in P-041

P-043 (Figs. 84 D, E) – **Tilt positioner** on one axis, base area and working surface 100 × 100 mm, tilt range ± 10°

P-044 (Figs. 84 F, G) – Tip and tilt positioner on two axes, size and tip and tilt range as in P-043



P-044

Fig. No. 6. Tip and Tilt Positioners

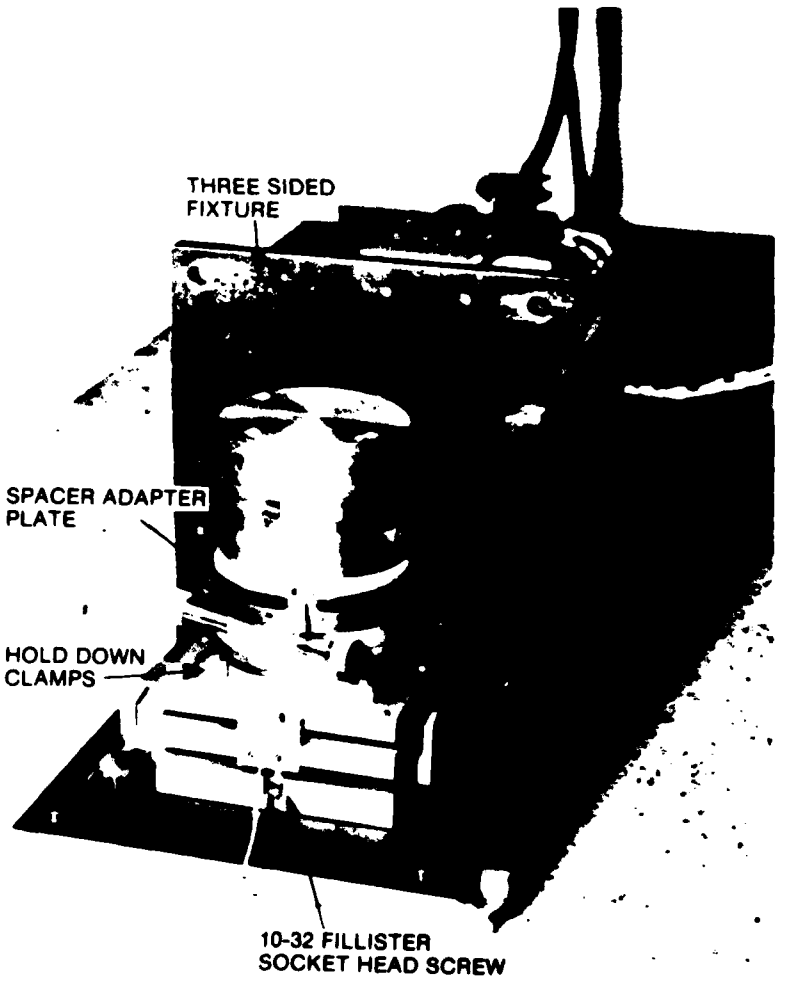


Fig. No. 7 Two-Degree-Of-Freedom Strapdown Gyroscope Alignment Fixture Package Mounted On A Three Sided Fixture

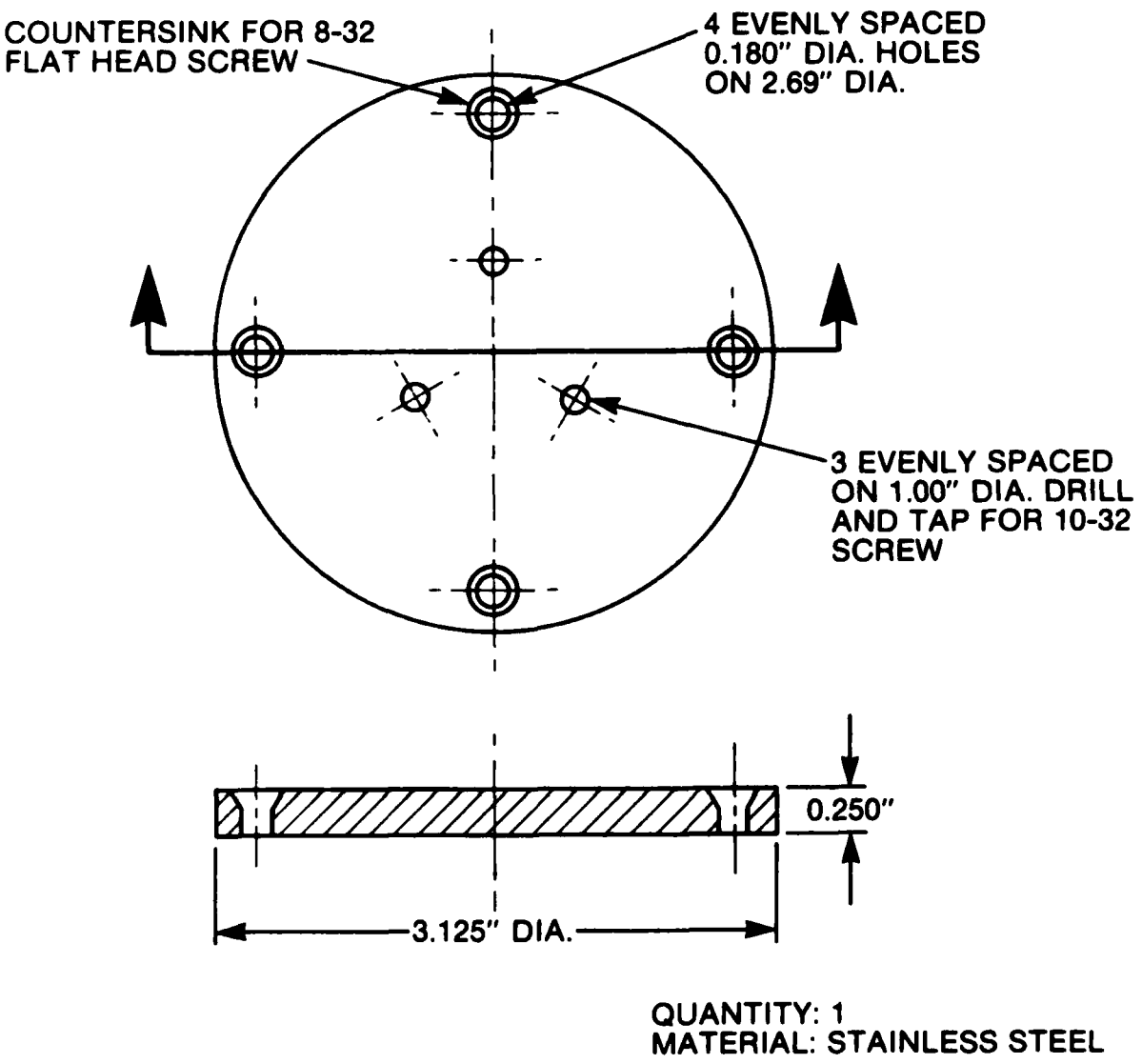


Fig. No. 8 Spacer Adapter Plate

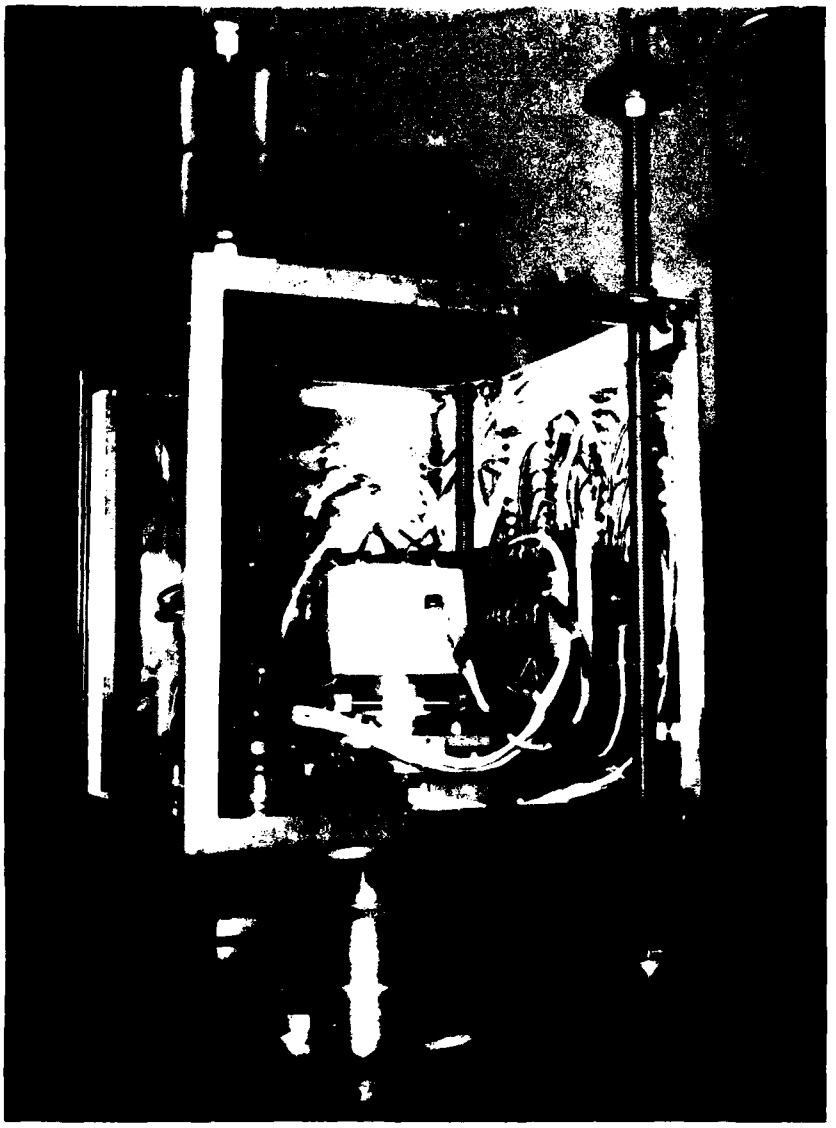


Fig. No. 9 Two-Degree-Of-Freedom Gyroscope Alignment Fixture Package Mounted On Test Table

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DOCUMENT CONTROL DATA - R & D
(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1 ORIGINATING ACTIVITY
DEFENCE RESEARCH ESTABLISHMENT OTTAWA
Department of National Defence
Ottawa, Ontario K1A 0Z4, Canada

2a DOCUMENT SECURITY CLASSIFICATION
Unclassified

2b GROUP

3 DOCUMENT TITLE
AN ALIGNMENT FIXTURE FOR A TWO-DEGREE-OF-FREEDOM (TDF) GYROSCOPE

4 DESCRIPTIVE NOTES (Type of report and inclusive dates)
Technical Note

5 AUTHOR(S) (Last name, first name, middle initial)
APPS, RENE, G.

6 DOCUMENT DATE
June 1984

7a TOTAL NO OF PAGES
14

7b NO. OF REFS

8a PROJECT OR GRANT NO
32G

9a ORIGINATOR'S DOCUMENT NUMBER(S)
DREO TN 84-5

8b CONTRACT NO

9b OTHER DOCUMENT NO.(S) (Any other numbers that may be assigned this document)

10 DISTRIBUTION STATEMENT
Unlimited

11 SUPPLEMENTARY NOTES

12 SPONSORING ACTIVITY
DREO

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KEY WORDS

Alignment Fixture

Two-Degree-of-Fredom (TDF) Gyroscope

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